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PRICING RULES FOR HOSPITALS

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No. 208

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The assistance of William Dickens is greatly appreciated. The author is also a Clinical Fellow, Massachusetts General Hospital.

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PRICING RULES FOR HOSPITALS

1. Introduction

The construction of an effective scheme of hospital rate regulation has become an important public policy problem. Yet surprisingly little attention has been directed to the design of the hospital's rate structure. My task in this paper is to investigate the following question: How far can we apply the economic theory of optimal pricing for public enterprises to the practical problem of setting hospital charges?

My perspective, therefore, is that the hospital is a regulated enterprise which must set prices in the public interest, subject to some sort of breakeven constraint. Although it may be presumptuous to regard the hospital as a bonafide public utility, the special position of this nonprofit firm in our society seems to make this a reasonable starting point.

Even in this narrower public enterprise context, there must be a hundred different ways of analyzing the hospital's price structure. Should prices reflect marginal costs or average costs? Should these costs be calculated to reflect anticipated technical change or alternative quality choices? Are there externalities to worry about? Should the hospital correct for distortions in input prices? Do we take uncertain demand into account? How about multi-part tariffs or other nonlinear pricing schemes? What product should we price anyway? Room and board? Syringes? Appendectomies?

Rather than producing an exhaustive compendium, I shall focus on those aspects of the hospital's rate structure which seem to be central to the role of this institution. In particular, the hospital will take explicit account of the risk-spreading and income distributional consequences of its pricing

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decisions. My main reason for this approach is to dispel the commonplace notion that hospitals should set prices at average costs. Paying attention to risk-bearing and income distribution is also a way of confronting inevitable questions about the special nature of the hospital's product. After all, coasting across Dupuit's bridge is not the same thing as having a heart attack or an abortion.

After this introduction, Section 2 focuses on the theoretical problem of public pricing when risk-spreading and distributional considerations are involved. For the most part, this is merely an extension of the literature on optimal pricing.[1] There is, however, a peculiar twist. We will have to question carefully the usual assumptions that social welfare should be titrated by willingness to pay or that in the case of serious illness the consumer always knows best.

In Section 3, attention is shifted to an empirical experiment of calculating optimal charges for a representative hospital, based upon the rules derived in Section 2. My data source is a study of the cost and production relations of a medium-sized, urban teaching hospital during the period 1971-1973.[2] Two different systems of product pricing are analyzed: the conventional product classification based upon ancillary services and daily accommodations; and an experimental alternative system of flat per diem charges according to diagnosis. These two pricing methods turn out to have very different properties. Although this type of experiment has all the limitations of any case study, my suspicion is that the results are typical of a wide class of hospitals in this country.

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[1] See for example Ramsey (1925), Samuelson (1951), Baumol and Bradford (1970), Dixit (1970), Boiteaux (1971), Diamond and Mirrlees (1971), Atkinson and Stiglitz (1972), Feldstein (March 1972, May 1972), Diamond (1975).

[2] See Harris (1975).

Finally, Section 4 pulls together the above results to suggest some practical approaches to the design of hospital rate structures. In particular, I will consider the relation between these theoretical pricing rules and those pricing practices which hospitals actually follow in the current regulatory environment.

Because of its necessarily limited scope, this paper ignores two important but related problems. Nothing is said about the design of pricing rules in a multiple hospital regime in which product quality and production efficiency may vary across hospitals. Furthermore, there may be strong interconnections between a hospital's market prices and those allocative instruments which a hospital might use to solve its critical internal control problems. These issues will be dealt with elsewhere.

2. The Second Best Again

I shall consider the hospital to be a multiple product monopoly which serves a closed community with a very large number of consumers. This theoretical approach abstracts from the fact that consumers in a particular locality may have access to many hospitals or that some hospitals accept distant referrals. It also finesses questions of physicians' admitting privileges at several hospitals or multi-hospital sharing arrangements. My point here is that most hospitals have, in some sense, a captive population. These captive customers, however, do not own the hospital. As usual, the analysis will be of the partial equilibrium type.

I will also assume that hospitalization insurance is available to members of this hypothetical community. These insurance policies are written by a third party separate from the hospital. The hospital cannot change the terms of these policies. These policies are of the reimbursement type and are characterized by fixed coinsurance rates. The coinsurance rates are allowed to depend on the various services the hospital offers. For example, there could be full coverage on daily, semiprivate room-and-board but 20 percent copayment on certain ancillary services. Although the inclusion of deductibles would be desirable, I will defer that possibility until later.

I will assume that hospitalization insurance is financed by a lump sum premium equal to the policy's actuarial value. These premiums are paid during a hypothetical second period. The discount rate is zero.

Finally, I will make some familiar assumptions necessary to render the total demand for hospital services nonstochastic. The uncertainty is thus concentrated solely on potential consumers. This permits me to avoid the problem of devising a rationing method during periods where demand exceeds short-run capacity -- a question which I will defer to another paper.[3]

Although the hospital cannot control the terms of insurance coverage or the government's redistributive policy, it does take into account the possibility that there may be distortions in the existing insurance system or in the distribution of income in this community. The price structure will therefore reflect the fact that a young man admitted with, say, a crippling brain hemorrhage may not have enough insurance or may be impoverished by the tragedy.

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[3] Previous approaches to the problem of pricing under uncertain demand have assumed that excess demand is rationed by either willingness to pay or according to some process of self-selection. See for example Brown and Johnson (1969, 1973), Visscher (1973), Carleton (1975), and Panzar and Sibley (1977). As Feldstein (1967), Rafferty (1971), and Harris (1977) have pointed out, however, the process of rationing excess demand in hospitals remains poorly understood. Another difficulty with previous approaches is that welfare is measured as the expected value of consumer surplus, a criterion which may be inappropriate in the current context. For some discussion of the use of peak-load pricing in hospitals, see Long and P. Feldstein (1967) and Berki (1972).

The problem is this: What prices should the hospital set to generate some mimimum required cash flow?

The Hospital as Insurance Company: I first regard each consumer as having the same initial resources and tastes. This assumption will be relaxed below. This representative individual is uncertain about his future state of health. States of health are assumed to vary independently across individuals. Following Arrow's (1976) notation, let x_{is} denote the representative individual's consumption of hospital service i when in state of health s. Let p_i be the (state-independent) price for hospital service i. Let $q_i = r_i p_i$ be the consumer's price for service i net of insurance, where r_i is the specified coinsurance rate for hospital service i. Let $U_s(\ldots, x_{is}, \ldots)$ denote the consumer's utility in state of health s. Let $V = E[U_s]$ denote the consumer's expected utility, where $E[\cdot]$ is the expectation operator across states of health. Let y_s be the consumer's pretax income in state s.

The assumption of a very large number of consumers with independently distributed risks of illness permits me to treat the demand for each hospital service as non-stochastic. Let x_i be the per capita supply of hospital service i. Then in equilibrium.

$$E[x_{is}] = x_i \qquad \text{all } i \qquad (1).$$

For each state of health s, the consumer maximizes U_s given prices $\{q_i\}$ and the budget constraint

$$\Sigma_j q_j x_{js} = y_s - \Sigma_j (p_j - q_j) x_j \qquad (2),$$

where the summation term on the right-hand side of (2) represents the insurance premium. The first-order conditions for utility-maximization in each state (ignoring corner solutions) are

$$\frac{\partial U_s}{\partial x_{is}} = \lambda_s q_i \qquad \text{all } i \qquad (3),$$

where λ_s is the marginal utility of income in state s.

I now want to find prices $\{p_i\}$ which maximize the representative consumer's expected utility $V = E[U_s]$ subject to a constraint on the hospital's (per capita) net revenue Π.[4] The first-order conditions (again ignoring corner solutions) include

$$\frac{dV}{dp_i} + \mu \frac{d\Pi}{dp_i} = 0 \qquad \text{all } i \qquad (4),$$

where $\mu > 0$ is the Lagrange multiplier for the net revenue constraint.

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[4] The requirement that hospitals break even, that is, $\Pi = 0$, is merely a special case. The more general case is considered here because a requirement of zero "economic" profits may mean that "accounting" profits must be positive. See Section 3 below.

After alot of technical manipulation, (4) yields the following expression:

$$\frac{p_i - mc_i}{p_i}\eta_{ii} = 1 - \frac{r_i E[\lambda_s x_{is}]}{\mu x_i} - \frac{E[\lambda_s]}{\mu}(1-r_i)(1-\eta_{ii})$$

$$+ \Sigma_{j \neq i}\left\{\frac{E[\lambda_s]}{\mu}(1-r_j) - \frac{p_j - mc_j}{p_j}\right\}\eta_{ij}\,\frac{p_j x_j}{p_i x_i} \qquad \text{all } i \qquad (5).$$

In this set of equations, mc_j is the marginal cost of service j and $\eta_{ij} = -\frac{q_i}{x_j}\frac{dx_j}{dq_i}$ is the cross-price elasticity demand. Note also that $E[\lambda_s]$ represents the utility of the composite good representing an extra dollar in each state of health.[5]

Equation (5) resembles the conventional Ramsey condition, except that there are additional terms which reflect the existence of insurance subsidies and the presence of risk effects. When there is no insurance

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[5] To derive (5), first differentiate the budget constraint (2) with respect to q

$$\Sigma_j q_j \frac{dx_{js}}{dq_i} + x_{is} = -\Sigma_j\left(\frac{1}{r_j} - 1\right)q_j\frac{dx_j}{dq_i} - \left(\frac{1}{r_i} - 1\right)x_i \qquad (a).$$

Evaluation of the first term in (4) yields

$$\frac{dV}{dp_i} = r_i\frac{dV}{dq_i} = r_i E\left[\Sigma_j \frac{\partial U_s}{\partial x_{js}}\ \frac{dx_{js}}{dq_i}\right]$$

$$= r_i E\left[\lambda_s \Sigma_j q_j \frac{dx_{js}}{dq_i}\right] \qquad (b),$$

coverage, i.e., $r_j = 1$ all j, equation (5) becomes

$$\frac{p_i - mc_i}{p_i}\eta_{ii} = \left(1 - \frac{E[\lambda_s]}{\mu}\right) - \frac{\mathrm{cov}[\lambda_s, x_{is}]}{x_i\mu} - \Sigma_{j\neq i}\frac{p_j - mc_j}{p_j}\eta_{ij}\frac{p_j x_j}{p_i x_i} \qquad \text{all } i \qquad (6).$$

In this expression $\mathrm{cov}[\lambda_s, x_{is}] = E[\lambda_s x_{is}] - E[\lambda_s]x_i$ is the covariance between the marginal utility of income and the consumption of service i across states of health.

The right hand side of (6) has three terms. The first term $(1 - \frac{E[\lambda_s]}{\mu})$ is analogous to the conventional Ramsey constant. The last term represents the usual adjustment for cross-price effects. The middle term represents a special adjustment for risk-bearing effects. As Arrow (1976) has argued,

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(footnote #5 continued from previous page)

where the second equality comes from (3). Plugging in (a) and using the definition of cross-price elasticity of demand, we get

$$\frac{dV}{dp_i} = -r_i E[\lambda_s x_{is}] - x_i E[\lambda_s]\cdot\left\{1 - r_i - \Sigma_j (1 - r_j)\eta_{ij}\frac{p_j x_j}{p_i x_i}\right\} \qquad (c).$$

The other term in (4) is

$$\mu\frac{d\Pi}{dp_i} = \mu x_i\left(1 - \Sigma_j \frac{p_j - mc_j}{p_j}\eta_{ij}\frac{p_j x_j}{p_i x_i}\right) \qquad (d).$$

Equation (5) is now obtained by plugging (c) and (d) into (4) and rearranging terms.

$\mathrm{cov}[\lambda_s, x_{is}]$ is likely to be positive for medical care services and therefore this adjustment term is negative.[6]

In the special case where $\eta_{ij} = 0$ $(i \neq j)$, equation (5) simplifies to

$$\frac{p_i - mc_i}{p_i}\eta_{ii} = (1 - \frac{E[\lambda_s]}{\mu}) - \frac{r_i}{\mu x_i}\mathrm{cov}[\lambda_s, x_{is}] + \frac{E[\lambda_s]}{\mu}(1-r_i)\eta_{ii} \qquad \text{all } i \qquad (7).$$

This expression also has three terms. In addition to the conventional Ramsey constant and a similar risk-bearing adjustment term, the third term $\frac{E[\lambda_s]}{\mu}(1-r_i)\eta_{ii}$ represents a correction for the distortion induced by insurance subsidization. Note that only under special circumstances do the second and third terms cancel out.[7] In general, solving the optimal pricing problem means solving the optimal insurance problem.

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[6] Arrow's argument depends on the validity of the assumption that the marginal utility of income does not decrease with increasingly severe illness. This assumption may be very dubious for a moribund patient, unless we redefine "consumer" to include (say) family and friends. Otherwise our rule might tell us to tax the terminally ill.

A similar covariance term appears in Feldstein's (March 1972) expression for optimal equity-adjusted prices and in Feldstein's (1973, p.272) expression for the welfare loss from increased risk-bearing. The similarity between the risk-corrected pricing rule and the equity-corrected pricing rule is that they are both corrections for heterogeneity--either across states of health or across individuals. This is also recognized by Leland and Meyer (1976).

[7] Equation (7) reduces to the familiar Ramsey rule if

$$r_i = \{ 1 + \frac{\mathrm{cov}[\lambda_s, x_{is}]}{\eta_{ii} E[\lambda_s] x_i} \}^{-1} \qquad \text{all } i.$$

Note that if the covariance between consumption and the marginal utility of income across states is positive, then the roots of these equations will be less than unity.

From (7), we can see that price adjustments to compensate for imperfect insurance coverage will depend not only on $\mathrm{cov}[\lambda_s, x_{is}]$ but also on the extent of insurance coverage and the elasticity of demand. For example, if a particular hospital treatment imposes a severe risk burden in the absence of insurance, but the current coverage for that treatment is quite extensive, then it is perfectly possible that a compensating price increase will be required. It is also possible that a hospital treatment which is inadequately insured should be priced below marginal cost. Even if there are long run constant returns and even if the net revenue constraint is set at $\Pi = 0$, average cost pricing could be inappropriate.

Although equation (7) is a reasonable formula, it may be unrealistic to assume that the cross-price elasticities η_{ij} are vanishing. Surgical operations and recovery room services are surely complementary goods. Conversely, more intensive chest physiotherapy may substitute for a longer in-hospital recuperation period in a pneumonia patient. The last term in equation (5) tells us that the price of a service will depend both on the price markups and on the extent of insurance coverage of substitutes and complements. For example, the magnitude of the price markup on the daily room rate would depend positively on the extent of insurance coverage of substitute ancillary services. Or to take a well known case, the hospital could lower the rates of those outpatient services which are underinsured. Alternatively, it could raise the rates of those inpatient treatments which are close substitutes for these outpatient services.

The Hospital as Robin Hood: We don't want to impose a price markup on someone in coma just because the Neurosurgical Intensive Care Unit is a good revenue raiser. But even if this patient has insurance, we may still be reluctant to tax his particular treatment if he is poor.

To introduce distributional considerations of this sort, suppose that our hospital community is now made up of consumers from several different social classes. Within each class consumers remain identical. Let x_{his} now represent the consumption of hospital service i by an individual of class h in state of health s. Similarly, let $V_h = E[U_{hs}]$ be the expected utility of an individual of social class h. Assume that there is a social welfare function W which depends on the V's but distinguishes individuals only by social class. Then our new rule is

$$\frac{dW}{dp_i} + \mu \frac{d\Pi}{dp_i} = 0 \qquad \text{all } i$$

or

$$\Sigma_h f_h W_h \frac{dV_h}{dp_i} + \mu \frac{d\Pi}{dp_i} = 0 \qquad \text{all } i \qquad (8),$$

where W_h is the partial derivative of W with respect to the expected utility of an individual in social class h, and f_h is the fraction of consumers belonging to class h.

In deriving a specific rule from (8), we would have to ask a variety of questions: Are the coinsurance rates now allowed to depend on social class? Do the price elasticities vary with social class? Can the lump-sum premium in the budget constraint (2) be adjusted for social class? The real-life answers to the above questions are most definitely in the affirmative. Nevertheless, the simplest case in which the r's, η's and taxes are independent of social class h is informative. With cross-price elasticities equal to zero, we have

$$\frac{p_i - mc_i}{p_i} \eta_{ii} = \left(1 - \frac{E[\Sigma_h f_h W_h \lambda_{hs}]}{\mu}\right) - \frac{r_i}{\mu x_i} \Sigma_h f_h W_h \operatorname{cov}[\lambda_{hs}, x_{his}]$$

$$+ \frac{E[\Sigma_h f_h W_h \lambda_{hs}]}{\mu} (1 - r_i) \eta_{ii} \qquad (9).$$

The main difference between this expression and equation (7) is that the second term on the right hand side may actually represent a positive correction. This will be the case when the consumption of a particular type of hospital care increases with respect to increasingly wealthy social class or if there is increasing risk aversion with respect to social class. The hospital thus performs a redistributive function by marking up prices on high-class types of medical care. Since our insurance financing scheme is by assumption regressive, the hospital is also compensating for the fact that higher class propensities to consume more medical care impose a burden on the lower classes through insurance premiums.

These risk-and distribution-corrected pricing rules can become quite complex once these severe restrictions are relaxed. For example, if we allow for the existence of complements and substitutes, then we will want to know the correlations between the degree of substitutability (or complementarity) and the social class distribution of consumption for each service. If hospital inpatient services are used more by lower social classes, then we will have even more reason to raise the inpatient rates relative to the outpatient clinic rates. Similarly, we might have subsidized private duty nursing care in a risk-conscious regime because it is typically not covered by insurance policies. But the inclusion of distributional factors may cause the hospital to reverse that pricing policy.

Nonlinear Prices: These second-best corrections for risk-bearing and distribution arise in part because the hospital cannot set different prices for each state of health and each social class. A separate price for (say) a chest xray for rich people who have pulmonary edema would in effect approximate a perfect contingent claims market and redistribution scheme. Although hair-line pricing schemes of this sort are infeasible, it must be recognized that there are a variety of alternative methods of risk and class discrimination embedded in many hospitals' current pricing practices. In addition to "stat" surcharges for emergency studies and special "private patient" services, one sees a variety of two-part pricing schedules. Rates for operating room time, blood bank services, cardiac catheterization, and other special studies frequently involve a set up charge and a marginal consumption price. In at least one specific instance I am aware of, an entrance or admission toll is levied in addition to specific charges for the consumption of routine care, ancillary and other services.[8]

Even if we make the restrictive assumption that all tariffs are independent of states of health and social class, we must still specify how these entrance and marginal consumption fees are to be covered in insurance policies. A set-up charge which is levied on everyone in the community independent of his consumption and which is not covered by insurance is, in effect, a head tax. If the admission toll is not covered by insurance but is levied only on those admitted to the hospital, we have in effect a system of insurance deductibles. Conversely, if admission tolls are covered by insurance, then we have the equivalent of a system of third party subsidy by case or capitation. These of course are only special cases. There is in principle an abundance of possibilities in which both consumers and third parties share in the payment of admission tolls and marginal charges. These setup tolls and marginal charges need not be levied on the same set of products. It is conceivable that entrance fees discriminate according to (say) diagnosis while marginal charges are based on (say) the consumption of various ancillary services. Such schemes may permit hospitals to discriminate finely among risk and income classes. Yet by "bunching" the consumption of many products in a single admission toll, they will avoid forcing consumers into complete nonutilization. In all of these arrangements, it is perfectly possible that the optimal marginal prices for some services will be above marginal cost while others will be below marginal cost. I shall return to these issues below.

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[8] See Wood (1976).

Whose Welfare Counts? These pricing rules may be legitimate in a world where consumers are well-informed about medical choices. But when someone is sick enough to get into the hospital, his consumption decisions are made to great extent by his doctor. In such a regime, it is just not clear whose willingness to pay is being measured. Our pricing rule might not reflect an individual patient's welfare, but rather his doctor's perception of his welfare. Even when the patient is alert, out of pain, and well educated about his choices, there is a strong paternalistic sense in which he could make a completely wrong decision. The hypertensive executive who refuses to be admitted for his heart attack because of the opportunity cost of his time may be making a rational decision. But the fact is that he is violating a scientific standard. In such a case, there is a reasonable argument to be made that hospitals should subsidize this type of consumption to prevent such an allegedly pathological denier from killing himself.

In practical applications of the above pricing rules, we would expect the measured elasticities η_{ij} to depend on the relative seriousness of the particular cases under treatment and on the existence of alternative treatment choices. The own-price elasticity for gall bladder surgery would depend on the extent to which treatment was elective. The cross-price elasticity with nonsurgical therapy would depend on (say) the value of medical drug treatment for gallstones. But these elasticities are also bound to reflect doctors' information about patients' insurance coverage and hospital rates, external pressures from medical peers and hospital administrators, or the possibility of malpractice. The own-price elasticity for skeletal xrays may be observed to be very close to zero merely because any patient who falls out of bed gets a skull xray to avoid litigation.[9]

Risk-bearing and distributional considerations aside, our pricing rules tell us to raise revenue on those types of hospital care which are least price sensitive. This may force us to tax those patients whose doctors are, in a sense, most "efficient". The price sensitivity of (say) hospital length of stay for a normal delivery may be quite low because obstetricians are discharging everyone in three days regardless of ability to pay. On the other hand, the price sensitivity of (say) hospital length of stay for herniorrhaphy may be considerable because a patient's lack of insurance coverage is the physician's only inducement to ambulate the patient more rapidly after surgery. In interpreting the experimental results which follow, we will therefore have to be careful that the prices do not induce undesirable distortions in the pattern of medical practice or patient's choices. We must also be wary that doctors' perceptions of patient welfare may be inappropriate criteria for pricing decisions.

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[9] There are a variety of other reasons for questioning the validity of "demand curve" measurements for hospital services. Supply considerations such as the degree of hospital occupancy and the day of the week (see Lave and Leinhardt (1977)) may influence the consumption decision. It is not entirely clear whether these supply factors will operate independently of the type of hospital service demanded.

3. An Experiment

Methods and Materials: This section reports some experimental results based upon the rules derived above. The data base for these calculations consisted of financial and diagnostic profiles for over thirteen thousand inpatient admissions to a 330 bed urban teaching hospital during the period 1971 to 1973. In addition to these detailed patient profiles, I had access to the prices and costs of the services offered by this hospital.[10] In what follows, I have had to make a number of simplifying assumptions merely to get results.

The study hospital followed the conventional practice of setting charges for each of its ancillary services as well as a separate per diem rate to cover routine nursing, housekeeping and administrative services. This pricing system was therefore used as a point of departure.[11] However, the availability of detailed clinical information on each of the study hospital's patients permitted me to experiment with an alternative product classification - namely, a flat per diem rate differentiated according to the patient's illness. Such a diagnostically-oriented pricing system has frequently been suggested because the conventional uniform daily rate may not adequately reflect variations in the actual costs of medical treatment.[12] Although one could experiment with a price system differentiated according to both type of service and diagnosis, a comparison of these two orthogonal cases seemed to be a good starting point.

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[10] All financial data is presented in current 1973 dollars.

Even for the average sized hospital, charge setting is a complicated business. In its totality, the study hospital's price list contained over 2,500 individual entries. A considerable amount of aggregation was therefore required merely to put these illustrative calculations in presentable form.[13] Eventually, the hospital's product vector was condensed to 29 elements, which included 25 different ancillary service categories and four different daily rates for room and board. Similarly, in the alternative method of distinguishing hospital services according to type of illness, the detailed data on discharge diagnoses were condensed into 29 aggregate clinical categories.[14]

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[11] There is the additional complication that only certain insurance schemes reimburse hospitals in accordance with their established charges, while other third parties require a variety of detailed cost reports. The analysis below abstracts from these complications by assuming that all third parties reimburse the hospital according to the same set of charges. See Section 4 below.

[12] A diagnostically-oriented rate structure may have some desirable properties as a means of comparing the rates of several hospitals or as a type of internal accounting device to promote cost consciousness among doctors. These possibilities must be analyzed elsewhere.

[13] The original price list, for example, contained seven different charges for minor surgical procedures of different durations as well as over 350 other charges for various operating room drugs and supplies. Aggregating these entries into a single product MINOR SURGERY would be free of distortions only if the demand for this aggregate product depended only on its price index and not on the relative prices of each component. See Willig (1976). The anecdotal evidence available to me suggests that hospital

An optimal pricing experiment of this sort requires that we know the own-price and cross-price elasticities for all of the hospital's services. Although estimates have been made for the price elasticity of hospital admissions and the elasticity of hospital inpatient length of stay conditional upon admission, there are no available estimates for individual ancillary services.[15] However, the fact that the extent of insurance coverage varied from patient to patient in the data base permits us to get some rough idea of the magnitudes of these price elasticities. Thus linear "demand equations" for each ancillary service and accommodation category were estimated by ordinary least squares regressions on the entire cross-section of over 13,000 admissions, where the patient's copayment fraction was the exogenous price variable. Analogous demand regressions

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[13] price setters in fact set charges for such aggregate categories before determining individual rates.

[14] These aggregate categories were obtained by further condensation of the product classes described in Harris (1975). Ancillary services were aggregated according to the hospital department (cost center) which provided the service. The various aggregate diagnostic categories were derived from a combination of apriori clinical groupings and analytical clustering techniques.

[15] See for example Feldstein(1971) and Newhouse and Phelps (1974, 1976). Some estimates of the price elasticity of inpatient length of stay for various types of illnesses have been made by Joseph (1972) and Rosenthal (1970). For a critical review, see Newhouse and Phelps (April 1974).

were performed to determine the price elasticity of length of stay for each of the diagnostic categories. These regression results are presented in the Appendix to this paper.

Hospitalization insurance policies generally specify a single coinsurance rate for all expenses rather than individual coinsurance terms for each type of service. Hence, there was insufficient variation in the data to measure separate own-price and cross-price elasticities. However, if the cross-price elasticities among hospital services are in fact relatively small, then these simple coinsurance elasticities will be reasonable estimates of the own-price elasticities of each service. Since the assumption of negligible cross-price effects between inpatient and ambulatory services is hardly tenable, only the study hospital's inpatient services were priced in this experiment.[16]

Since the estimated copayment elasticities represent only the own-price elasticity of demand conditional upon admission to the hospital, it was necessary to increment these values by estimates of the elasticity of admission with respect to each product price. These procedures are described in the Appendix.

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[16] For some policies (such as Medicare) separate copayment provisions are specified for per diem accommodations and ancillary services. However, some preliminary experiments with the use of two explanatory copayment variables gave unsatisfactory results. The exclusion of ambulatory and emergency services is valid if changes in relative prices within the inpatient category do not affect the costs or demands of these outpatient services. Extension of the current results to include outpatient care and substitutes or complements is an important direction for future research.

The elimination of cross-price effects permits us to use equations (7) and (9) to calculate optimal prices. These formulas, however, require that we know the covariance between the marginal utility of income and the consumption of each service. Although one can derive a closed expression for this term by assuming a specific utility function and frequency distribution of consumption,[17] this experiment used a more ad hoc procedure. Each patient in the data base was assumed to have a marginal utility of income of the form

$$\lambda = Ae^{-Ry} \qquad (10),$$

where R is a constant representing the absolute risk aversion, where y represents each patient's income, and where A is a constant chosen so that the average marginal utility of income across all patients is unity.[18] We can then obtain a nonparametric estimate of $\text{cov}[\lambda_s x_{is}]$ for each service i merely by calculating the sample covariance between the consumption of service i and the marginal utility of income as expressed in (10).[19]

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[17] See for example Arrow (1976), Appendix 1.

[18] This choice for the value of A in (10) allows us to set $E[\lambda_s] = 1$ in equation (12).

[19] Strictly speaking, the expression $\frac{r_i \ \text{cov}[\lambda_s, x_{is}]}{x_i}$ must be calculated across all states of health, including those states where the representative consumer is not admitted to the hospital. Making this calculation across only those individuals in the inpatient sample is valid if the event of admission to the hospital is distributed independently of the consumption of particular hospital services, or if the hospital is concerned with the welfare of those individuals who consume some hospital services. Although both of these assumptions are somewhat dubious, my hand was forced by my lack of any good data on the probability of admission for various types of consumers.

For each optimal pricing calculation, two sets of covariances were calculated. First, in order to determine the isolated effects of risk-bearing considerations on prices, each patient's net income y was calculated by subtracting his actual out-of-pocket hospital bill from a constant, representative annual per capital income.[20] Second, in order to include income distributional considerations, each patient's net income y was calculated by subtracting his actual out-of-pocket hospital bill from an estimate of his actual annual income based on insurance status, room accommodation and age.[21] In both sets of covariance calculations, the absolute risk aversion parameter R was assigned several reasonable alternative values.

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[20] It was not entirely clear whether y should reflect a measure of short-run income or long-run wealth or whether y should reflect personal or family income. In this experiment, y was taken to be annual per capita income. If we choose an income y of $5000, then an appropriate value for R is of the order of 2×10^{-4}, which represents a relative risk aversion of 1. Values of R ranging from 10^{-4} to 7×10^{-4} were infact used by Feldstein (1973).

[21] These income values ranged from $2000 per capita for medicaid patients to $15,000 for self-pay patients in private suites. The device of using the patient's actual income to calculate the relevant covariance implicitly assumes that the social welfare function W has the same exponential form as (10). In that case, the calculated value of λ for a patient represents the marginal social value of a dollar going to that patient. The parameter R then measures the absolute risk aversion of the social welfare function.

Since we have the data available to calculate $\text{cov}[\lambda_s, x_{is}]$, as well as estimates of each own-price elasticity and a demand curve for each product, we are in a position to solve the set of nonlinear equations implied by (7) (or (9)) and the constraint on hospital cash flow. These equations were solved by a straightforward iterative method.[22]

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[22] Note that (7) can be written in the form

$$\frac{p_i - mc_i}{p_i}\eta_{ii} = \frac{1}{\mu}(1 - \mu + \delta_i) \qquad \text{all } i. \qquad \text{(a)},$$

where

$$\delta_i = -\frac{r_i}{x_i}\text{cov}[\lambda_s, x_{is}] + (1 - r_i)\eta_{ii} \qquad \text{all } i.$$

(By construction, $E[\lambda_s] = 1$; see footnote 18.) To solve (a), I made a once-and-for-all calculation of δ_i based on the current price elasticity, the current copayment fraction for each service, and the current covariance between the marginal utility of income and consumption. The parameter δ_i on the right hand side of (a) was then taken as constant. This simplification assumes that the calculated value of δ_i at current prices is close to its value at the optimal prices. Some separate calculations of δ_i at the optimal prices supported this assumption.

The procedure was then to select an initial value for μ, solve each equation in (a) for p_i, and then use the linear demand curves to calculate total revenues. We then iterate on values of μ until the net revenue constraint is satisfied to an accuracy of one per cent. Experiments with the estimation and application of isoelastic demand curves ran into the same difficulties encountered by Bailey and Willig (1976). In particular, the results yielded extreme values for the prices of those products with the lowest own-price elasticity. For example, the Ramsey-optimal daily charge for Complex Intensive Care patients in the case of an isoelastic demand curve turned out to be over $8,000., while all other cases were priced below marginal cost. For a more general approach to this demand curve specification problem, see Bailey and Willig (1976).

A Note on Costs: In these optimal price calculations, marginal costs were represented by short-run direct costs derived from a managerial accounting project in progress at the study hospital. The use of short-run rather than long-run marginal cost-- which in most hospitals accounts for no more than half of average total cost-- is justified only if the hospital's services are being utilized at less than full capacity. Although this assumption may not be valid for all hospitals, there was considerable evidence to support its application to the study hospital.[23]

When there is growing demand pressure on existing facilities, on the other hand, marginal cost calculations should somehow reflect the projected incremental costs of expanded capacity. This may be no simple task in a regime of rapid technical change. The fact that some cross-sectional studies of hospitals show constant returns tells us very little about the correct method of calculating these long-run incremental costs.[24] One merely has to wander through a hospital's historical hodgepodge of buildings dedicated to various benefactors to recognize this.

When the anticipated costs of capacity expansion depend on uncertain projections about the state of demand, the growth of new technology, the timing of regulatory decisions and the lumpiness of expansion, then the calculation of long-run incremental costs becomes as much an accounting problem as an economic problem. The task of attributing anticipated costs to a particular revenue-generating item is so bound up in questions of causality, identifiability and joint responsibility that the whole business ends up to be more an adventure in internal dispute settling and incentive control than anything else.[25] In sum, a hospital price setter faced with the problem of allocating the costs of anticipated expansions may have to treat a great part of the necessary costs an accounting overhead.

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[23] The average daily occupancy for the study hospital during 1971-1973 was 79%. Subsequent calculations of shifts in demand for the hospital's services induced by a move to optimal prices suggested that average daily occupancy would not exceed 83%.

[24] The various ad hoc methods currently used by hospitals to allocate overhead costs are not appropriate for this task. The correct method is to calculate the shadow prices of inputs from the appropriately specified optimization problem. This is another important area for future research.

This viewpoint is consistent with the observation that hospitals generally produce a sizeable positive cash flow. And it is not really important in the current context whether this represents true economic profit or just covered overhead. As Turvey (1969) has emphasized, the revenue raising requirement for a public enterprise may have nothing to do with strict increasing or decreasing returns. If the hospital price setter has to come up with more revenue than he can reasonably assign to marginal costs, then that price setter must find the best way to make patients and third parties pay that revenue. Therefore, in the results which follow, the net revenue constraint has been set so that the study hospital's overhead or indirect costs are completely covered.

Results: Table 1 displays some selected optimal pricing results for the study hospital's ancillary services and daily accommodations. The first column corresponding to each service (SRMC) represents the short-run

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[25] See Harris (1975), chapter 3.

TABLE 1: OPTIMAL PRICES FOR ANCILLARY SERVICES AND DAILY ACCOMMODATIONS

		SRMC	P_0	P_I	P_{II}	P_{III}
1.	ELECTROENCEPHALOGRAM	22.	33.	75.	15.	7.
2.	PHYSICAL THERAPY	6.	19.	16.	14.	12.
3.	ELECTROCARDIOGRAM	5.	26.	21.	17.	18.
4.	RESPIRATORY THERAPY	5.	18.	25.	-0.70	-5.30
5.	CARDIAC CATHETERIZATION LAB	376.	584.	753.	562.	834.
6.	MAJOR SURGERY	250.	442.	953.	105.	302.
7.	MAJOR ANESTHESIA	187.	163.	359.	209.	243.
8.	MINOR SURGERY	114.	88.	158.	165.	154.
9.	MINOR ANESTHESIA	74.	79.	105.	123.	120.
10.	CHEMISTRY TEST	1.10	5.20	4.00	3.60	3.00
11.	IMMUNOASSAY TEST	2.40	10.00	8.30	7.10	7.04
12.	MICROBIOLOGY SPECIMEN	2.50	12.10	8.40	8.30	6.00
13.	BLOOD BANK SERVICE	3.50	18.30	14.80	7.10	7.60
14.	HEMATOLOGY TEST	1.40	4.70	3.90	3.60	3.30
15.	SEROLOGICAL TEST	1.50	8.00	6.00	5.70	4.60

TABLE 1 continued:

		SRMC	P_0	P_I	P_{II}	P_{III}
18.	CENTRAL SUPPLY ITEM	2.60	2.80	4.30	3.30	2.60
19.	DRUG ORDER	0.60	1.10	1.20	1.20	1.20
20.	CHEST XRAY	6.10	32.	23.	19.	15.
21.	GASTROINTESTINAL XRAY	21.	63.	50.	57.	52.
22.	SKELETAL & "STAT" DIAGN. XRAYS	8.	26.	45.	2.10	-5.30
23.	ANGIOGRAPHY STUDY	120.	186.	416.	33.	152.
24.	NUCLEAR MEDICINE STUDY	43.	68.	76.	82.	77.
25.	NEURORADIOLOGY STUDY	94.	173.	369.	86.	300.
26.	C.C.U. & I.C.U. DAYS	105.	131.	144.	170.	172.
27.	PRIVATE ROOM DAY	33.	102.	48.	98.	121.
28.	SEMIPRIVATE ROOM DAY	31.	95.	42.	91.	89.
29.	WARD DAY	29.	35.	36.	80.	73.

marginal cost of that service. The next column (P_0) denotes the actual 1973 unit price for each service. The remaining three columns represent the results of three different types of optimal pricing calculations. Column P_I displays the conventional Ramsey-optimal prices for each service, derived from (7) by assuming $r_i = 1$, all i, and R = 0. The calculated prices under P_I therefore represent the optimal method of raising revenue to minimize consumers' deadweight losses. Risk-bearing and distributional considerations are not incorporated.[26] Column P_{II} displays the optimal prices calculated from equation (7) under the assumption that all consumers have the same income. These prices therefore take risk-bearing considerations into account but not income distribution. Finally, column P_{III} displays the optimal prices which include both risk-bearing and income distributional considerations. In the calculations P_{II} and P_{III} presented in Table 1, the absolute risk aversion parameter R was taken to be 10^{-4}.

It should be no surprise that the estimated elasticities for the hospital's services were very low, ranging from 0.01 for ANGIOGRAPHY to 0.16 for WARD DAYS. As a result, the conventional Ramsey numbers based on current prices were very much less than the value of one predicted for a perfectly discriminating monopolist.[27] One reasonable interpretation of this finding is that almost any inpatient service sold by a hospital could be used to raise revenue. However, there were substantial differences in own-price elasticity even at this low range of price sensitivity. The estimated price elasticities of PHYSICAL THERAPY and MINOR SURGERY were three times the price elasticities of ANGIOGRAPHY and MAJOR SURGERY. The latter two services were associated with illnesses so severe that the price elasticity may not be significantly different from zero. One could argue that these differences in price sensitivity should be taken into account in the design of optimal prices.

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[26] We could also assume that each r_i satisfies the conditions in footnote 7.

[27] The Ramsey numbers are the values of $\frac{p_i - mc_i}{p_i}\eta_{ii}$ for each product. These ranged from -0.01 for MINOR SURGERY to 0.11 for WARD DAYS.

The Ramsey-optimal prices in column P_I of Table 1 are displayed in Figure 1, in which the hospital's services are grouped into broad functional categories. Each vertical bar represents the percentage change the current price for each hospital service. These results represent a substantial shift in the study hospital's current rate structure. The rates for routine diagnostic tests, for certain routine xrays and for non-intensive care room accommodations could be greatly reduced at the expense of surgery, special diagnostic studies such as ANGIOGRAPHY, and certain routine therapeutic services such as RESPIRATORY THERAPY. Although these results are influenced by the relative differences in price elasticity between specialized and routine services, they are also determined by variations in the current markups of prices over short run marginal costs. This finding is consistent with the well-known observation that hospitals ordinarily markup high volume routine services and the daily room rates in an attempt to cross-subsidize their specialized studies.

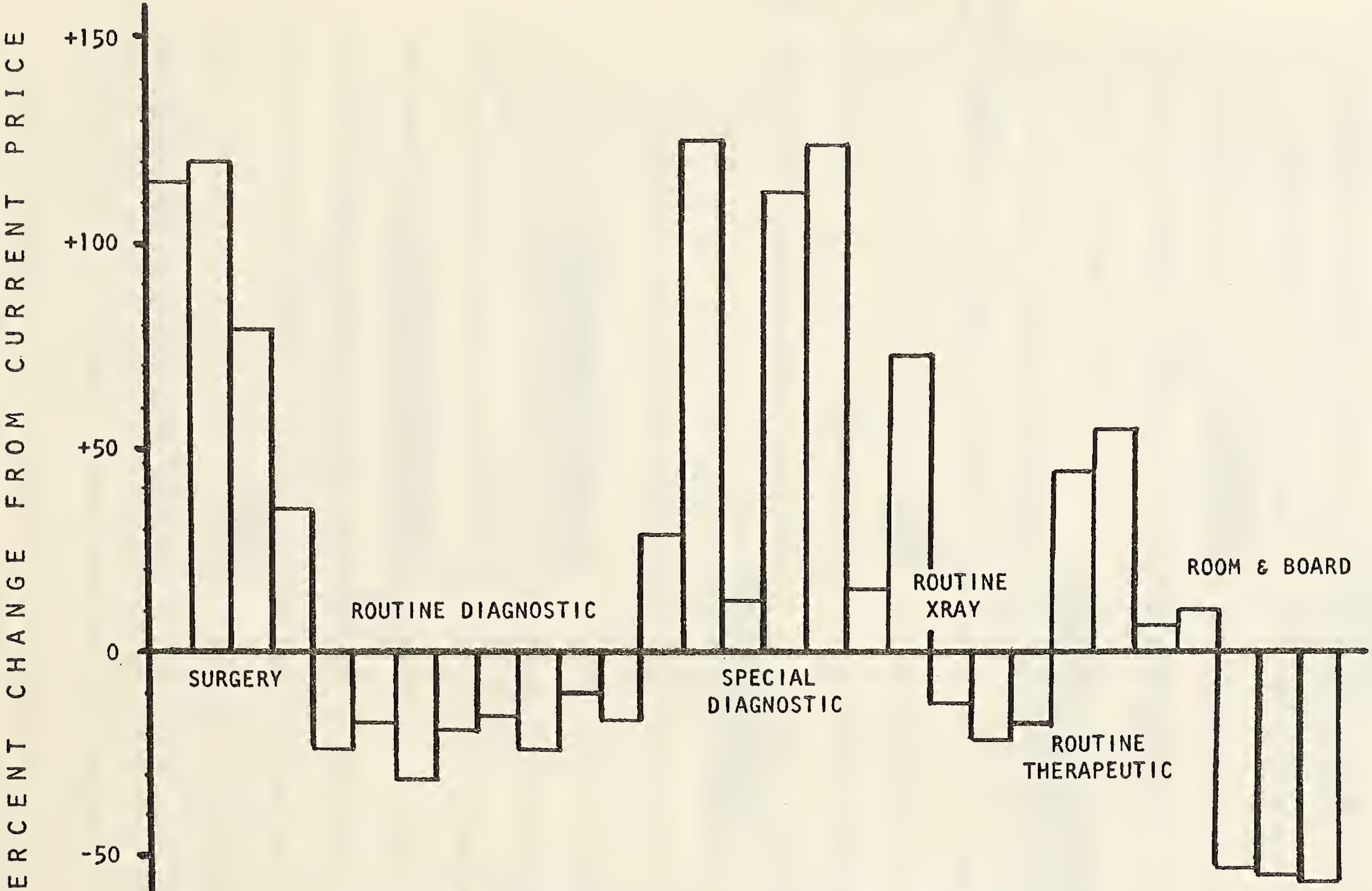

FIGURE 1: THE MOVE FROM CURRENT TO RAMSEY-OPTIMAL PRICES FOR ANCILLARY SERVICES AND DAILY ACCOMMODATIONS

When risk-bearing and distributional considerations are introduced, however, these optimal price changes make some big reverses. A particular ancillary service may be a good revenue-raising item because it is ordered mostly in patients with serious illnesses. However, these patients may be the hospital's poorest customers or have the least adequate insurance coverage. These factors will tend to reduce the optimal price. Thus, the Ramsey-optimal price for an ELECTROENCEPHALOGRAM in Table 1 is $75.00, but the optimal prices in columns P_{II} and P_{III} are below marginal cost. RESPIRATORY THERAPY is associated with sufficiently catastrophic illness that the optimal policy is literally to give away these services.

Of course considerations of efficiency and risk-bearing or efficiency and equity are not necessarily counterbalancing. A particular hospital service with a high price elasticity might be consumed primarily by individuals with little insurance and/or low incomes. Products of this type are, in a sense, "inferior goods". As the extent of insurance coverage increases or as income rises, there is a substitution to higher quality services. It is also possible that a particular hospital service is "inferior" in one sense and "normal" in another. If these effects turn out to be important, then we could observe any combination of synergies or cancellations as we take risk-bearing and distribution into effect.

Risk-bearing and distributional corrections of this sort are depicted for selected services in Figure 2. The optimal prices calculated in Figure 2 were based upon a value of $R = 2 \times 10^{-4}$. MAJOR SURGERY is so price-inelastic that its conventional Ramsey-optimal price is more than

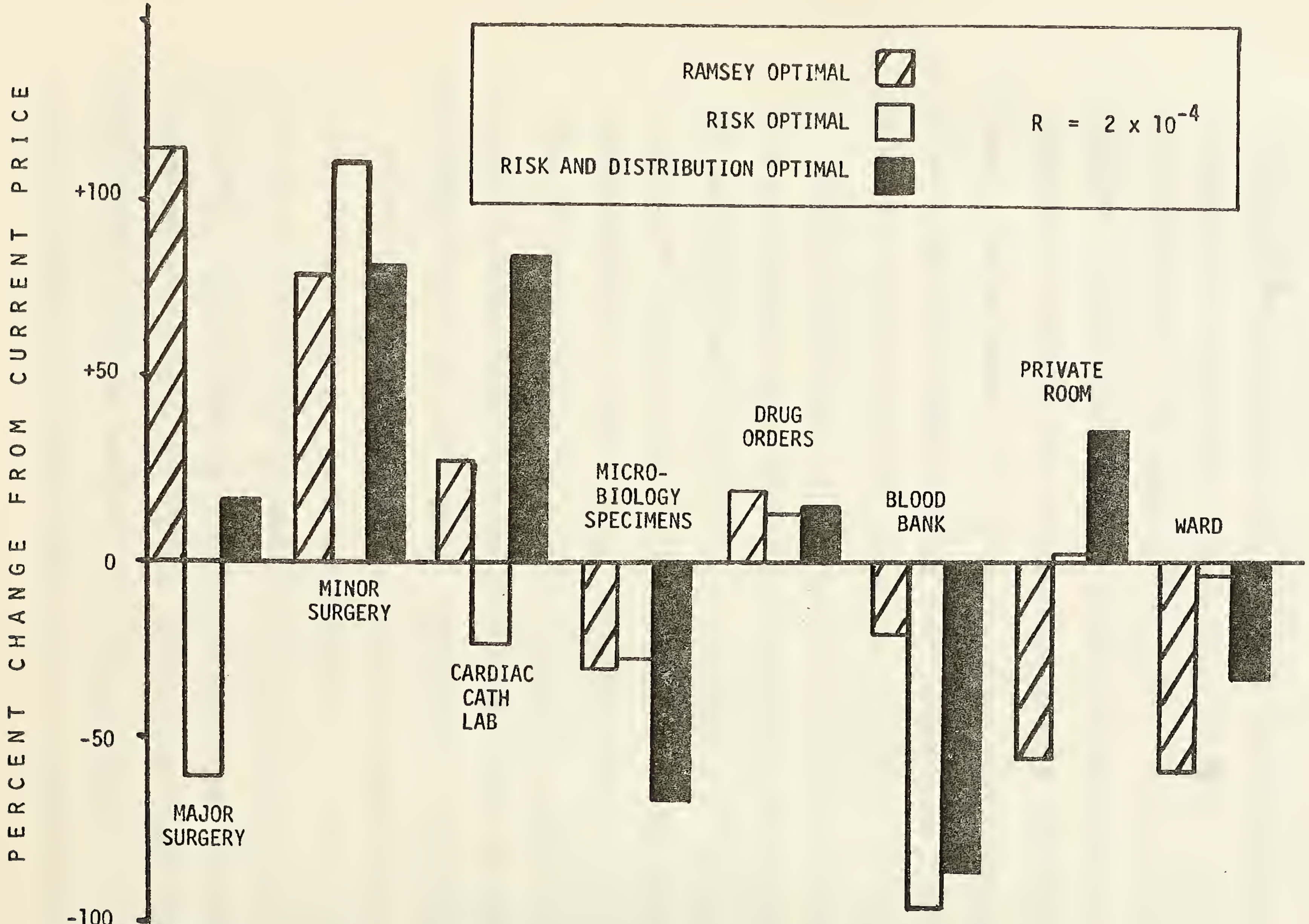

FIGURE 2: THE MOVE FROM CURRENT TO RAMSEY OPTIMAL, RISK OPTIMAL, AND RISK AND DISTRIBUTION OPTIMAL PRICES FOR SELECTED SERVICES.

double the current charge. However, this hospital service is associated with insurance coverage so inadequate that its risk-optimal price (P_{II}) is less than half of its original charge. However, MAJOR SURGERY (especially open heart surgery) was provided primarily to higher-income consumers in this study hospital. Hence, the risk and distribution optimal price (P_{III}) ends up very close to the current charge.

On the other hand, MINOR SURGERY was consistently underpriced by the study hospital. As shown in Table 1, this resulted in part from the fact that minor surgery was currently priced below cost. One could speculate that the current price structure had something to do with the cross-subsidization of MAJOR and MINOR surgical procedures. The results in column P_{II}, however, suggest that MINOR SURGERY was in fact "overinsured" relative to other hospital services, while the result in P_{III} reflected the bias of minor surgical operations toward Medicare and Medicaid patients.

CARDIAC CATHETERIZATION, we find, was biased so heavily toward higher income patients that the risk and distribution optimal price P_{III} requires a considerable markup. MICROBIOLOGY SPECIMENS represents the interesting case of a routine diagnostic service used in large proportion by Medicaid patients whose insurance coverage is near complete. The move to Ramsey optimal or to risk optimal prices is a moderate price decrease to correct for the huge markup in the current price structure. But the inclusion of distributional considerations pushes the price way down. DRUG ORDERS, on the other hand, are distributionally neutral. BLOOD BANK SERVICES, no matter how one looks at it, should be heavily subsidized.

It is also interesting to note that the risk optimal rates for daily accommodations are very close to the current prices. The inclusion of distributional considerations, however, requires a greater degree of price discrimination than currently practiced in the study hospital. I will return to this point below.

Table 2 depicts the optimal pricing results for the alternative product classification scheme. In this case, a unit of consumption is one day in the hospital for a patient with a particular diagnosis. The first column ("SRMC") again represents the estimated short-run marginal cost per day for each illness category.[28] The column P_0 represents the mean total charge per day incurred by each illness category under the current rate structure. Columns P_I, P_{II}, and P_{III} represent respectively the Ramsey optimal, risk optimal, and risk and distribution optimal daily rates. Two additional columns are presented in Table 2. The column Q_I represents the net out of pocket daily rate calculated from the prices in column P_{III} and the current copayment fractions for patients in each illness category. The amounts in column Q_{II} represent the total insurance reimbursements per hospital stay, based upon the prices in column P_{III}.

The conventional Ramsey optimal daily rates in column P_I tell a simple story. The study hospital should raise the per diem charge on OPEN HEART

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[28] These marginal costs were mean values imputed to each diagnostic category on the basis of the estimated costs of ancillary services and basic nursing.

TABLE 2: OPTIMAL DAILY ACCOMMODATION RATES BY DIAGNOSTIC CATEGORY

		SRMC	P_0	P_I	P_{II}	P_{III}	Q_I	Q_{II}
1.	CANCER, MEDICAL	61.	214.	151.	194.	194.	17.	2800.
2.	CANCER, SURGICAL	93.	252.	187.	235.	235.	22.	5100.
3.	HEART ATTACK	58.	182.	189.	201.	204.	19.	5300.
4.	OPEN HEART SURGERY	202.	430.	658.	535.	590.	72.	13100.
5.	HEART DISEASE, SIMPLE	53.	187.	143.	176.	176.	18.	2000.
6.	HEART DISEASE, COMPLICATED	52.	188.	165.	192.	192.	14.	4000.
7.	GASTROINTESTINAL, MEDICAL SIMPLE	46.	172.	92.	129.	129.	14.	1100.
8.	GASTROINTESTINAL, MEDICAL COMPLIC.	47.	178.	139.	167.	168.	17.	2000.
9.	GASTROINTESTINAL SURGERY	86.	244.	221.	252.	251.	24.	4100.
10.	RESPIRATORY DISEASE	68.	199.	155.	193.	190.	17.	2700.
11.	UROLOGICAL SURGERY	63.	187.	155.	186.	184.	18.	1700.
12.	ABORTION AND D. & C.	99.	213.	166.	207.	204.	21.	520.
13.	OTHER GYNECOLOGY	71.	186.	168.	195.	193.	21.	1800.
14.	NEUROLOGY	55.	174.	135.	166.	166.	16.	1700.
15.	DEBILITATING CEREBROVASC. ACCIDENT	68.	160.	208.	202.	195.	16.	8900.
16.	E.N.T. & OPHTHALMOLOGIC SURGERY	67.	178.	109.	146.	145.	12.	490.
17.	ORTHOPEDIC SURGERY, SIMPLE	58.	169.	109.	143.	146.	17.	1200.

TABLE 2 continued:

		SRMC	P_0	P_I	P_{II}	P_{III}	Q_I	Q_{II}
18.	BACK PAIN, NON SURGICAL	34.	139.	71.	102.	103.	10.	1100.
19.	ORTHOPEDIC SURGERY, COMPLIC.	70.	200.	167.	198.	201.	21.	3800.
20.	SIMPLE SURGICAL TRAUMA	63.	187.	117.	149.	140.	32.	380.
21.	COMPLICATED SURGICAL TRAUMA	70.	189.	154.	183.	176.	28.	1500.
22.	COMPLEX INTENSIVE CARE	99.	236.	935.	387.	383.	40.	10800.
23.	CHRONIC RENAL DIALYSIS	122.	293.	131.	145.	146.	68.	140.
24.	BREAST BIOPSY	87.	224.	143.	190.	191.	17.	650.
25.	SIMPLE PLASTIC SURGERY	67.	169.	109.	142.	142.	20.	750.
26.	ADVERSE DRUG EFFECTS	74.	241.	126.	173.	171.	30.	570.
27.	OTHER MEDICAL, COMPLIC.	52.	179.	142.	172.	169.	14.	3300.
28.	OTHER MEDICAL, SIMPLE	45.	176.	103.	140.	140.	14.	1300.
29.	ACUTE TERMINAL ILLNESS	204.	568.	362.	475.	468.	32.	1200.

SURGERY to $658., and the per diem charge on COMPLEX INTENSIVE CARE cases to $935. These price increases would have negligible effects on the admission rate and length of stay for patients of these types. But it would permit the study hospital to subsidize its relatively simple cases. Because of the relatively low estimated own-price elasticities, the move to Ramsey-optimal prices would produce only minor shifts in the study hospital's case mix and only a two percent increase in the average occupancy rate. The average daily charge for (say) an abortion, would be decreased by 22 percent.

This finding is of course not unexpected, but it does dramatize the importance of risk bearing and distributional considerations in the pricing policy of the hospital. A significant fraction of the COMPLEX INTENSIVE CARE cases were young people wrecked in automobile accidents, often with no insurance coverage. The fact that other patient's charges subsidized this type of catastrophic illness--indeed the mere fact that such patients were admitted without insurance--suggests how much the study hospital played Robin Hood and insurance company for its community.

The moderating effects of risk bearing and distributional factors are illustrated in columns P_{II} and P_{III} in Table 2. The optimal price for COMPLEX INTENSIVE CARE is reduced from $935 to $387 per day. Nevertheless, becasue of the relatively high marginal cost for these cases, this adjustment still represents an increase over the current daily rate. For a majority of the diagnostic categories, in fact, the P_{II} and P_{III} optimal prices were quite close to the current daily rates. Except for

OPEN HEART SURGERY, GASTROINTESTINAL MEDICAL SIMPLE, BACK PAIN, SIMPLE SURGICAL TRAUMA, COMPLEX INTENSIVE CARE, CHRONIC RENAL DIALYSIS, and ADVERSE DRUG EFFECTS, all prices in column P_{II} were within twenty percent of their current values. It is further noteworthy that the addition of income distributional considerations had little effect on the results. With the exception of an increase in the daily charge for OPEN HEART SURGERY, the prices in column P_{III} are virtually indistinguishable from those in P_{II}.

The interpretation of these findings is not at all clear. The near identity of columns P_{II} and P_{III} suggests that across diagnoses, the extent of insurance coverage is not correlated with income. Hence, risk-conscious pricing is just as good as equity-conscious pricing. The finding that optimal prices are so close to current imputed rates suggests that this system of product classification is relatively neutral with respect to insurance coverage and income distribution.[29] But there is the alternative possibility that the study hospital is somehow pricing diseases "rationally". I will return to this point below.

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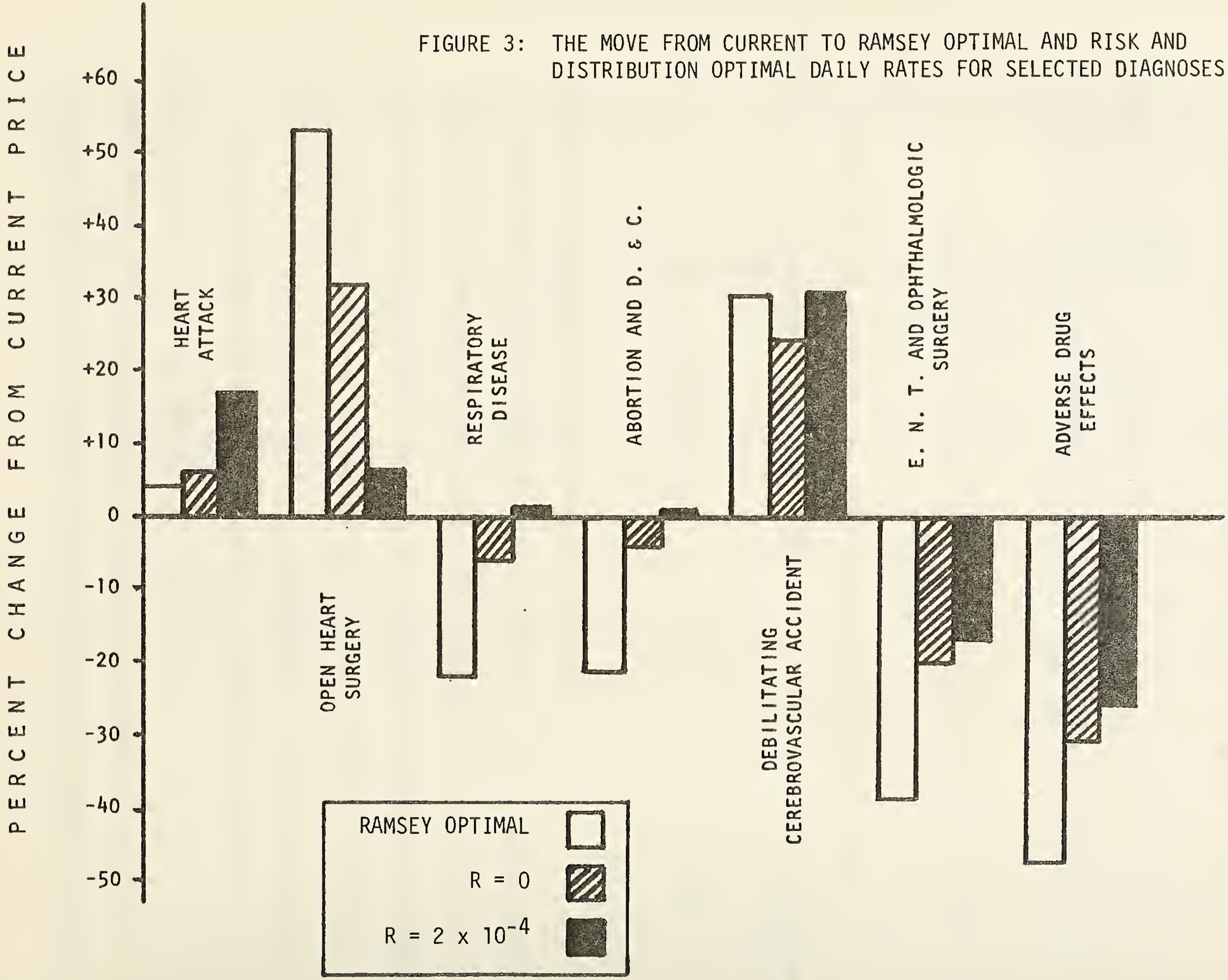
[29] This neutrality may be the result of my aggregating many different diseases to arrive at a manageable diagnostic classification. A more compelling explanation is that the fractions of Blue Cross and commercially insured patients is relatively constant across illnesses. Although there is considerable substitution among Medicare and Medicaid patients across illnesses, their combined proportion was also relatively constant. Since my welfare function is individualistic only with respect to income, each disease turns out to be "neutral". It would be interesting to repeat these results for a social welfare function based on age, sex and race.

The sensitivity of these results to variations in the absolute risk aversion parameter R is depicted in Figure 3. Price changes for Ramsey optimal prices, and for risk and distribution optimal prices at two values of R are shown for selected diagnostic categories. At the extreme value R = 0, the representative consumer's utility function is linear: hence, the resulting optimal prices correct only for the distortion induced by insurance subsidization.

Most of resulting price variations were typified by those for RESPIRATORY DISEASE and ABORTION AND D. & C. in the figure. As risk-bearing and distributional considerations became more important, the optimal prices on the less expensive, less serious conditions approached the imputed current daily rates. The same qualititive results were obtained for such diagnostic categories as E.N.T. and OPHTHALMOLOGIC SURGERY and ADVERSE DRUG EFFECTS, where the Ramsey optimal deviations from current prices were more marked. The results for OPEN HEART SURGERY illustrate a similar effect for expensive, serious illness. There were, however, exceptions. For example, the price elasticity of length of stay for HEART ATTACKS was sufficiently high that the introduction of insurance corrections actually raised the optimal daily rate. The move to the optimal daily rate at $R = 2 \times 10^{-4}$ was an increase because the estimated value of $\mathrm{cov}[\lambda_s, x_{is}]$ across all heart attack cases was actually negative. This observation resulted from the fact that higher income and better insured individuals had longer post-infarction recuperation periods than lower income individuals. The same effect was noted in the case of

FIGURE 3: THE MOVE FROM CURRENT TO RAMSEY OPTIMAL AND RISK AND DISTRIBUTION OPTIMAL DAILY RATES FOR SELECTED DIAGNOSES



disastrous strokes. The recuperative period after strokes was sufficiently income and price sensitive that the hospital must compensate low income individuals by taxing the strokes.[30]

One might ask which of the two alternative pricing systems is superior in terms of social welfare. Unfortunately, I did not employ the kind of unified theory of consumer utility necessary to make absolute social welfare comparisons. However, it is possible to compare the *improvements* in social welfare achieved by the move to optimal prices for each pricing system. We can approximate the welfare gain for a representative individual achieved by shifting to optimal prices as

$$\Delta V \sim \Sigma_i \frac{dV}{dp_i} \Delta p_i \qquad (14),$$

where Δp_i represents the absolute price change. Using the theory developed in Section 2, and assuming zero cross-price elasticities, we get

$$\Delta V \sim -\Sigma_i \{ r_i \text{cov}[\lambda_s, x_{is}] + x_i E[\lambda_s](1-\eta_{ii}(1-r_i)) \} \Delta p_i \qquad (15).$$

This expression can be evaluated from the above optimal pricing results. These calculations are presented in Table 3, which indicates the welfare

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[30] This conclusion arises in part because our optimal price formula in (9) assumes that the insurance premium structure is regressive.

TABLE 3: WELFARE GAINS PER CASE ACHIEVED BY THE MOVE FROM CURRENT TO OPTIMAL PRICES

	RISK OPTIMAL PRICING		RISK AND DISTRIBUTION OPTIMAL PRICING	
	$R = 10^{-4}$	$R = 2 \times 10^{-4}$	$R = 10^{-4}$	$R = 2 \times 10^{-4}$
Ancillary Service and Daily Accommodation Charges	$ 200.	470.	460.	1370.
Daily Rates by Diagnostic Category	30.	20.	40.	30.

gain achieved by the move from current to risk optimal prices or from current to risk and distribution optimal prices for both product classification schemes.[31]

As Table 3 suggests, the welfare improvements resulting from the move to optimal charges for ancillary services and daily accommodations were substantial, while the welfare gain associated with optimal diagnostically oriented daily rates was no more than one percent of the current hospital charge per case.[32]

The conventional system of charges according to ancillary services, it appears, has a much greater capability of discriminating among patients of different risk classes than the hypothetical alternative system of per diem charges according to diagnosis. In principal, of course, we could have a rate structure which is differentiated in both dimensions, with different rates for private or ward rooms for different types of illnesses. It is unclear, however, how burdensome such a rate structure would be. In a second best setting in which we can choose only one system, the conventional method at least appears to have more potential.[33]

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[31] The calculations of ΔV in Table 3 use the values of x_i and η_{ii} at the optimal prices. Similar results were obtained when the current values of x_i and η_{ii} were used.

[32] Variations in ΔV in the second row are within the error of approximation of formula (15).

[33] This tentative conclusion assumes that the current rate structure is no better or worse for consumer welfare than a system of diagnostically-oriented daily rates imputed from current charges. The findings in Table 3 also suggest that diagnosis-based rates can be determined from current charges without much welfare loss. This conclusion, if correct, greatly simplifies the task of constructing such rates, since few if any

4. Pricing Rules for Hospitals

The finding that risk and distribution optimal rates were in many cases close to current prices is not really so coincidental. There is a natural tendency for equity and risk-bearing considerations to counterbalance efficiency. This is not the place to quarrel over the objective function of nonprofit enterprises. But it is important to recognize that there are many factors in the current regulatory environment which actually push hospitals toward a form of welfare-oriented price discrimination.

It is common practice in hospital finance, for example, to mark up the prices of so-called "high volume" routine items. The logic behind this rule of thumb is straightforward. Suppose the price setter must raise additional revenues. If the demand for most hospital services is price inelastic, or if the price setter has little information by which to distinguish the price elasticities of various services, then it makes sense to make a small price increment on a high-volume item. In a regulatory regime where each price change is publically scrutinized, it is much easier to raise $10,000 by incrementing the charge for a blood sugar by fifty cents than by raising the charge for a pneumonencephalogram by $250. To a great extent, the substantial markup on routine, high-volume items observed in the study hospital (and probably in most other hospitals) is

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(footnote # 33 continued from prior page.)
hospitals can produce a detailed costing analysis and patient classification of the sort used in the current study. For some attempts to impute diagnostically-oriented rates from current charges, see Thompson, Fetter and Mross (1975).

the historical result of repeated exercises in this type of logic.

This is not the only basis for the cross-subsidization which is so commonplace in the hospital's price structure. For a variety of reasons, the hospital administrator is always under pressure to generate sufficient demand to justify the existence of certain prestigious services. Furthermore, in some cases there may be special price adjustments for those procedures used by the hospital's most renown doctors. Finally, there is the phenomenon of differential regulatory noise by various third party payors. As long as some third parites generate more flak about reimbursing some services than others, the price setter is going to shift around the rate structure to reflect each third party's path of least resistance.

In the process of trying to satisfy so many watchdogs and gadflies, the hospital may eventually end up with a price structure approximating the second best optimum. One might not regard this as the simplest price setting algorithm. But the fact is that if (say) a state Medicaid agency yells loud enough, a hospital will make the rich patients pay.

As we approach a regime in which hospital regulation becomes more coherent and centralized, we will want to develop more operational rules for setting charges. If a regulatory agency decides that a particular hospital's revenues reflect excessive organizational slack or too much standby capacity, then there will have to be some rational method for adjusting charges accordingly. Hospitals are not expected to collect all of the managerial data necessary to replicate this sort of pricing experiment. But one can conceive of a system in which the hospital's services are partitioned into broad functional categories; short-run direct costs are estimated without the typical full-cost allocation process; and the necessary overhead is raised by price markups which explicitly reflect the distribution of income, insurance coverage, and case severity across these product categories. Such an approximation method would at least make pricing objectives explicit. It would also dispense with the theoretical and behavioral fiction that hospitals price at a magically derived, fully allocated average cost.[34]

Does this experiment give us any definitive rule about the type of product to price? The fact that the conventional pricing system already has some built-in discriminatory capabilities is, in a way, a mixed blessing. For the potential distortions from errors are as great as the potential gains. Many of the price adjustments in the above experiment may have resulted from differences in the style or type of clinical care received by rich and poor patients. One could view these class distinctions as an opportunity to price discriminate. For example, in Table 1, column P_{III}, the study hospital could raise the private room rate by twenty dollars in order to lower the semiprivate and especially the ward room rate. But if one regards opportunity to discriminate room rates by social class as an invitation to provide lower quality medical care to poorer patients, then the conventional charge system is plainly unacceptable.

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[34] For an earlier critique of average cost pricing in hospitals, see Davis (1971). See also Berki (1972). There is the additional and possibly more important advantage to the explicit accounting of marginal costs in this type of fixed capacity institution. A manager may be able to use overhead assignments as internal incentive payments for efficient performance. This is to be distinguished from the current accounting mysticism in which the manager of chemistry laboratory is socked with a huge accounting loss just because the regulator's accounting form by rule assigns (say) 22% of the laundary expenses to his cost center. These internal control issues will be considered elsewhere.

This suggests that the most appropriate rate structure for hospitals would be a hybrid of the conventional pricing system and a more neutral, diagnosis-based rate structure. Although I have not formally derived an optimal mixing for (say), diagnosis-based entrance fees and service-based marginal charges, one can get a rough idea of the magnitudes of these charges from the last two columns of Table 2. If we constrain our pricing system so that entrance tolls are insured and marginal prices represent patient payments, then column Q_{II} tells us the insured magnitude of entrance tolls for each diagnosis and column Q_I tells us how much the patient actually pays out-of-pocket per diem. In fact the possibility that hospital's could display their out-of-pocket consumers' prices separately from third party tolls seems to be much more logical than the current cumbersome billing system.

In principle, one can imagine all sorts of interesting block pricing arrangements. Third parties could reimburse hospitals by (say) diagnosis-specific set up charges and marginal per diem rates. Or the consumer could pay a deductible based on both diagnosis and type of accommodation, while third parties would reimburse according to conventional ancillary service and accommodation charges. These possibilities should be the focus of future research.

Appendix: This appendix presents those methods used to estimate price elasticities for various hospital services. Price elasticities consisted of two components: the price elasticity of demand conditional upon admission; and the price elasticity of admission. The former were obtained from regression results displayed below. The latter were derived from my best guesses based upon demand studies in the literature.

Separate sets of independent regressions were performed on the inpatient sample for both the conventional product classification and for the diagnosis-based classification. In the first set of 29 regressions, the dependent variables were the 25 ancillary services consumed per hospital admission and the inpatient lengths of stay for the four different types of room accommodation. Except for patients with ACUTE TERMINAL ILLNESS, all 13,273 admissions were included as observations. In the second set of regressions, the inpatient sample was partitioned into 29 diagnostic categories and a separate regression was performed for each subsample with inpatient length of stay as the dependent variable. Hence, the first set of regressions estimates the determinants of consumption per case for each ancillary service and of length of stay per case for each type of room accommodation. The second set of regressions estimates the determinants of inpatient length of stay for each diagnosis.

In the first set of regressions, explanatory variables included: the patient's copayment fraction derived from the terms of his insurance policy (COPAY, ranging from 0 to 1), the natural logarithm of patient age (ℓn AGE), a dummy variable equal to 1 if the patient's primary accommodation was a ward bed (WARD); and dummy variables for the patient's diagnostic classification.[35] The WARD dummy variable was included as a reasonable proxy for income. The other age and diagnostic variables were included because the extent of insurance coverage is likely to vary systematically with these demand determinants.

Table A presents the first set of regression results. Indicated are the coefficient estimates for the constant term, COPAY, *ℓn* AGE and WARD, their standard errors, the mean value of the dependent variable, the R^2 for the regression, and the estimated coinsurance elasticity of demand at the average coinsurance rate.[36]

As one might surmise from the observed mean values of certain dependent variables, some types of ancillary services were often not consumed at all during an admission. Although this might produce biases of sample truncation, the fact is that these dependent variables were usually consumed no more than once during an admission (eg., CARDIAC CATHETERIZATION LAB, MAJOR SURGERY, ANGIOGRAPHY STUDY). Hence, these particular regressions are best viewed as the equivalent of linear probability models. If this interpretation is valid, the regression results for (say) MINOR SURGERY indicate that a shift from full coverage to no coverage lowers the probability of receiving a minor surgical operation by 5.4 percent. To be sure, there will be heteroskedasticity-a problem present in all of the regressions because the discrete nature of the dependent variables. But it is not clear how much efficiency loss or bias in the estimates of the standard errors is present for such a large sample. Although one might have used a Tobin-modified probit procedure on a subsample of observations, my suspicion is that these ordinary least squares estimates provide a satisfactory indication of the relative magnitudes of the COPAY coefficients.

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[35] Only the coefficients of the constant term, COPAY, *ℓn* AGE and WARD are presented in Table A. These regressions were performed by transforming the dependent variables into their deviations from their mean values for each diagnostic category. Therefore, to obtain the predicted value of the dependent variable for any given observation, we must add back the mean value of the dependent variable for that patient's diagnosis.

[36] MEAN represents the mean value of the dependent variable over all diagnoses. The R^2 statistic indicates the fraction of the variance of the untransformed dependent variable explained by the COPAY, *ℓn* AGE, WARD and the diagnosis dummy variables.

As the results in Table A suggest, the inpatient use of various types of ancillary services is significantly price sensitive, but the price sensitivities are relatively small. And at the average copayment fraction of about 10%, the resulting price elasticities are all less than 0.03.

Although the COPAY coefficients are the focus of the analysis, the other results provide some interesting insights into the determinants of hospital care. Although many *ln* AGE coefficients were significantly positive, there were significant negative coefficients for the surgical procedures, SEROLOGICAL TEST, and NEURORADIOLOGY STUDY. For surgical services, these findings may reflect the fact that age represents a substantial risk factor in the decision to operate. The result for NEURORADIOLOGICAL STUDY probably represents the dominance of traumatic head injuries and other acute intracranial catastrophes among younger individuals or, again, the increased risk of complications from these xray studies in the elderly. Similarly, serological tests comprise mostly diagnostic screens for syphilis, hepatitis and pregnancy.

If the WARD dummy in fact reflects income, then income elastic goods should have negative coefficients. The fact that some WARD coefficients are significantly positive reflects a mix of factors. The WARD variable may reflect the seriousness of illness, or the substitution of alternative types of treatments as income or social class varies. The positive coefficient in the ward dummy in the PHYSICAL THERAPY regression may represent the fact that WARD patients are more bed-ridden. The positive coefficient in the ROUTINE URINALYSIS regression or for MICROBIOLOGY SPECIMEN may reflect a higher incidence of infection. On the other hand, the significant coefficient in CENTRAL SUPPLY ITEM may reflect the increased dependence of ward patients on hospital-supplied amenities. The negative sign in the DRUG ORDER regression suggests that higher income patients are generally willing to pay for palliative measures for insomnia, pain and constipation. The strong negative coefficient for the WARD dummy under intensive care days is bothersome. Sicker ward patients may have died in the ICU earlier (despite my attempt to exclude the early deaths from the sample), but I doubt if this is the only factor. The fact that so many WARD coefficients are negative suggests that hospital care is a "normal good". These questions clearly need further research, as they are crucial to the optimal pricing results when distributional considerations enter.

Table B presents the regressions for length of stay for each of the 29 separate diagnostic categories. Again, many of the COPAY coefficients are significant but relatively small. Surprisingly, some of the more serious illnesses have the most price sensitive length of stay. One interpretation of this finding is that the magnitude of the recuperative period after an initial insult is sufficiently discretionary to be sensitive to price variations. This is especially true for CANCER SURGERY, HEART ATTACK, and HEART DISEASE COMPLICATED. The results are consistent with a length of stay elasticity of 0.04 for all types of illnesses estimated by Newhouse and Phelps (1976).

Most of the WARD coefficients in these regressions are insignificant. The few which are significant have positive coefficients. Does this mean in those cases that hospital stay is an inferior good? Again, this finding may reflect the fact that poorer patients are more seriously ill. But a more attractive interpretation in some cases may be the availability of alternatives to continued hospitalization for higher income patients. Staying in the hospital after an abortion may indeed be an inferior good.

To obtain the total elasticity of consumption for each of these product descriptions we must increment these inpatient elasticities by an estimate of the elasticity of demand for admission. In the alternative product classification of diagnosis-specific length of stay. I based my calculations on the aggregate estimate of 0.17 presented recently by Newhouse and Phelps. Each of the 29 diagnoses was graded independently in terms of severity and attributed an elasticity of 0.24, 0.17 or 0.10, depending upon the presumed case severity.[36]

For the conventional product classification based on ancillary services and patient days by type of accommodation, the problem is more difficult. To begin with, there are no separate estimates available in the literature for the admission elasticity with respect to the ancillary service price, although my suspicion is that it is smaller than that for the daily room rate. Secondly, even if we assume the inpatient demand ancillary services have zero cross-elasticities, it is still possible that the admission decision is sensitive to all ancillary prices. If there were a single coinsurance rate for all hospital services, then the coinsurance elasticity of admission would represent the sum of the price elasticities of admission with respect to each ancillary service. Hence, the individual admission elasticities are likely to be extremely small. As a reasonable compromise, I incremented each of the ancillary service elasticities by 0.01, the intensive care days elasticity by 0.05 and the patient days elasticity by 0.10.[37]

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[36] In an alternative experiment, I tried incrementing each conditional elasticity by 0.17, independent of the presumed severity of the diagnosis. Although the Ramsey-optimal prices were somewhat different, the risk and distribution optimal prices were again very close to the current imputed charges.

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[37] In some other experiments, I measured the effect of varying the price elasticity of one item. For example, changing the elasticity of INTENSIVE CARE days had a marked effect on its optimal price in all versions, but little effect on the other product prices.

TABLE A: REGRESSION RESULTS FOR INPATIENT USE OF ANCILLARY SERVICES AND TYPES OF ROOM ACCOMMODATION.

	DEPENDENT VARIABLE	CONST	COPAY	*ln* AGE	WARD	MEAN	R^2	ELAS
1.	ELECTROENCEPHALOGRAM	-0.002	0.010	0.000	-0.004	0.26	0.26	-0.005
		(0.048)	(0.029)	(0.012)	(0.015)			
2.	PHYSICAL THERAPY	-1.670	-0.189	0.432	0.195	0.97	0.27	0.021
		(0.205)	(0.123)	(0.052)	(0.063)			
3.	ELECTROCARDIOGRAM	-1.965	-0.221	0.535	-0.224	1.72	0.49	0.014
		(0.136)	(0.081)	(0.035)	(0.042)			
4.	RESPIRATORY THERAPY	-4.602	-0.174	1.193	0.277	5.25	0.24	0.004
		(0.937)	(0.560)	(0.238)	(0.286)			
5.	CARDIAC CATHETERIZATION LAB	0.015	-0.006	-0.003	-0.012	0.05	0.28	0.014
		(0.018)	(0.011)	(0.005)	(0.006)			
6.	MAJOR SURGERY	0.050	-0.000	-0.011	-0.034	0.26	0.55	0.000
		(0.024)	(0.014)	(0.006)	(0.007)			
7.	MAJOR ANESTHESIA	0.101	-0.010	-0.025	-0.020	0.26	0.41	0.005
		(0.026)	(0.016)	(0.007)	(0.008)			
8.	MINOR SURGERY	0.047	-0.054	-0.013	0.035	0.31	0.24	0.020
		(0.036)	(0.021)	(0.009)	(0.011)			
9.	MINOR ANESTHESIA	0.173	-0.040	-0.042	-0.034	0.17	0.22	0.028
		(0.025)	(0.015)	(0.006)	(0.008)			
10.	CHEMISTRY TEST	-20.143	-5.198	5.377	1.275	28.53	0.29	0.018
		(2.501)	(1.495)	(0.635)	(0.765)			
11.	IMMUNOASSAY TEST	-0.191	-0.101	0.064	-0.182	0.61	0.15	0.017
		(0.116)	(0.070)	(0.030)	(0.036)			
12.	MICROBIOLOGY SPECIMEN	-1.042	-0.605	0.250	0.732	2.73	0.19	0.022
		(0.381)	(0.228)	(0.097)	(0.117)			

		CONST	CO-PAY	$\ln$ AGE	WARD	MEAN	R^2	ELAS
13.	BLOOD BANK SERVICE	-1.945 (1.183)	-0.958 (0.707)	0.615 (0.300)	-1.212 (0.362)	6.66	0.31	0.015
14.	HEMATOLOGY TEST	-2.790 (0.878)	-1.760 (0.525)	0.813 (0.230)	-0.350 (0.269)	9.69	0.29	0.019
15.	SEROLOGICAL TEST	0.418 (0.086)	-0.079 (0.052)	-0.112 (0.022)	0.094 (0.026)	0.50	0.07	0.017
16.	ROUTINE URINALYSIS	-0.288 (0.079)	-0.124 (0.047)	0.074 (0.020)	0.095 (0.024)	1.32	0.11	0.011
17.	PATHOLOGY & CYTOLOGY SPECIMEN	-0.091 (0.044)	-0.056 (0.026)	0.025 (0.011)	0.013 (0.014)	0.47	0.34	0.013
18.	CENTRAL SUPPLY ITEM	-12.625 (3.811)	-3.179 (2.277)	3.172 (0.967)	4.059 (1.165)	22.20	0.17	0.015
19.	DRUG ORDER	-8.017 (1.418)	-3.863 (0.847)	2.295 (0.360)	-1.028 (0.434)	19.74	0.33	0.020
20.	CHEST XRAY	-0.458 (0.117)	-0.168 (0.070)	0.123 (0.030)	0.051 (0.036)	1.43	0.24	0.013
21.	GASTROINTESTINAL XRAY	-0.197 (0.065)	-0.097 (0.039)	0.052 (0.017)	0.049 (0.020)	0.43	0.23	0.023
22.	SKELETAL & "STAT" DIAGN. XRAY	-0.718 (0.172)	-0.018 (0.103)	0.188 (0.044)	0.011 (0.052)	1.67	0.19	0.001
23.	ANGIOGRAPHY STUDY	0.009 (0.025)	0.005 (0.015)	-0.001 (0.006)	-0.024 (0.008)	0.08	0.11	-0.007
24.	NUCLEAR MEDICINE STUDY	-0.108 (0.051)	-0.061 (0.031)	0.032 (0.013)	-0.028 (0.016)	0.27	0.16	0.022

	CONST	CO-PAY	*ℓn* AGE	WARD	MEAN	R^2	ELAS
25. NEURORADIOLOGY STUDY	0.038 (0.014)	0.007 (0.009)	-0.009 (0.004)	-0.016 (0.004)	0.04	0.21	-0.020
26. C.C.U. & I.C.U. DAYS	-0.151 (0.168)	-0.001 (0.100)	0.048 (0.043)	-0.150 (0.051)	0.72	0.24	-0.000
27. PRIVATE ROOM DAY	-0.605 (0.329)	0.005 (0.197)	0.159 (0.084)		1.12	0.04	-0.000
28. SEMIPRIVATE ROOM DAY	-6.427 (0.668)	-2.143 (0.400)	1.754 (0.171)		10.44	0.32	0.021
29. WARD DAY	0.283 (0.329)	-0.789 (0.197)	-0.047 (0.084)		1.12	0.05	0.061

TABLE B: REGRESSION RESULTS FOR INPATIENT LENGTH OF STAY BY DIAGNOSIS.

	DEPENDENT VARIABLE	CONST	COPAY	*ln* AGE	WARD	MEAN LOS	MEAN COPAY	R^2	ELAS
1.	CANCER, MEDICAL	-1.236 (7.702)	-8.783 (3.654)	4.388 (1.858)	0.666 (1.485)	16.0	.09	.02	.05
2.	CANCER, SURGERY	9.561 (9.378)	-16.344 (3.667)	4.198 (2.253)	-1.676 (1.867)	24.2	.09	.06	.06
3.	HEART ATTACK	13.444 (17.703)	-14.675 (5.035)	4.771 (4.216)	-1.896 (3.133)	31.5	.09	.05	.04
4.	OPEN HEART SURGERY	5.842 (15.175)	-0.490 (6.569)	5.082 (3.927)	5.355 (7.081)	25.4	.12	.02	.00
5.	HEART DISEASE, SIMPLE	-4.776 (2.611)	-3.625 (1.633)	4.449 (0.639)	0.151 (0.787)	12.7	.10	.06	.03
6.	HEART DISEASE, COMPLICATED	3.249 (8.729)	-21.055 (7.036)	5.139 (2.078)	-1.353 (2.561)	22.7	.07	.03	.07
7.	GASTROINTESTINAL MEDICAL SIMPLE	4.041 (2.973)	-4.984 (1.554)	1.479 (0.780)	1.981 (0.811)	9.3	.11	.04	.06
8.	GASTROINTESTINAL MEDICAL COMPLICATED	9.099 (4.514)	-2.502 (2.594)	1.042 (1.121)	0.614 (1.172)	13.0	.10	.01	.02
9.	GASTROINTESTINAL SURGERY	4.187 (4.767)	-1.043 (3.201)	3.373 (1.205)	2.781 (1.182)	17.8	.10	.02	.00
10.	RESPIRATORY DISEASE	-10.442 (5.522)	-7.043 (2.775)	6.620 (1.352)	1.416 (1.156)	15.6	.09	.05	.04
11.	UROLOGICAL SURGERY	-5.330 (2.842)	-2.471 (2.084)	3.965 (0.723)	1.990 (0.870)	10.2	.10	.06	.02
12.	ABORTION and D. & C.	-2.900 (0.894)	-0.352 (0.428)	1.695 (0.264)	0.510 (0.197)	2.8	.10	.07	.01

		CONST	COPAY	*ℓn* AGE	WARD	MEAN LOS	MEAN COPAY	R^2	ELAS
13.	OTHER GYNECOLOGY	-15.774	-1.151	7.336	0.153	10.3	.11	.15	.01
		(2.905)	(1.376)	(0.787)	(0.684)				
14.	OTHER NEUROLOGY	-1.738	-4.012	3.427	-0.263	11.2	.09	.06	.03
		(2.101)	(1.533)	(0.532)	(0.672)				
15.	DEBILITATING CEREBROVASCULAR ACCIDENT	47.120	-12.541	0.714	3.629	49.9	.08	.03	.02
		(26.917)	(8.656)	(6.410)	(3.622)				
16.	E.N.T. & OPHTHALMOLOGIC SURGERY	-3.860	-3.069	2.333	0.342	3.6	.09	.25	.07
		(0.645)	(1.043)	(0.189)	(0.369)				
17.	ORTHOPEDIC SURGERY, SIMPLE	-6.295	-2.455	4.376	-0.552	9.2	.11	.10	.03
		(2.286)	(1.637)	(0.607)	(1.003)				
18.	BACK PAIN, NON SURGICAL	-10.149	-6.891	5.835	0.356	11.6	.10	.10	.06
		(4.448)	(3.153)	(1.135)	(1.854)				
19.	ORTHOPEDIC SURGERY COMPLICATED	-13.859	-5.027	9.103	6.193	21.2	.11	.15	.03
		(5.597)	(3.838)	(1.431)	(2.048)				
20.	SIMPLE SURGICAL TRAUMA	3.030	-0.615	0.202	-0.197	3.5	.23	.02	.04
		(0.709)	(0.276)	(0.194)	(0.199)				
21.	COMPLICATED SURGICAL TRAUMA	0.892	-2.308	2.651	0.450	10.3	.16	.05	.04
		(2.046)	(0.897)	(0.540)	(0.533)				
22.	COMPLEX INTENSIVE CARE	-11.873	19.992	10.066	7.162	31.6	.10	.06	-.07
		(13.078)	(8.804)	(3.217)	(3.193)				
23.	CHRONIC RENAL DIALYSIS	3.159	-1.232	-0.288	5.118	1.5	.46	.40	.37
		(1.697)	(0.312)	(0.433)	(0.502)				
24.	BREAST BIOPSY	-2.136	-2.370	1.554	1.917	3.7	.09	.16	.06
		(2.247)	(1.353)	(0.591)	(0.607)				
25.	SIMPLE PLASTIC SURGERY	-0.655	-2.558	1.894	1.285	6.1	.14	.06	.06
		(2.344)	(1.167)	(0.618)	(0.701)				

	CONST	COPAY	*ℓn* AGE	WARD	MEAN LOS	MEAN COPAY	R^2	ELAS
26. ADVERSE DRUG EFFECTS	1.715	-2.074	0.817	-0.687	3.9	.18	.13	.09
	(1.603)	(0.582)	(0.428)	(0.409)				
27. OTHER MEDICAL, COMPLICATED	5.552	-5.439	3.777	2.861	21.1	.08	.03	.02
	(5.512)	(3.481)	(1.340)	(1.305)				
28. OTHER MEDICAL, SIMPLE	-4.814	-2.023	3.919	0.061	10.1	.10	.06	.02
	(2.139)	(1.380)	(0.540)	(0.620)				
29. ACUTE TERMINAL ILLNESS	3.616	-1.921	-0.018	-0.263	3.0	.18	.09	.11
	(1.864)	(0.391)	(0.448)	(0.316)				

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